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THE ECONOMICS OF PROPERTY TAXES AND LAND VALUES

by

Ronald E. Grieson

Number 72

June, 1971

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I would like to thank Ralph Beals, Matthew Edel, John R. Harris, Jerome Rothenberg, and Carl Shoup for their comments, criticisms and encouragement.



The important problem of the incidence and deadweight loss of property taxes, along with the determination of land values, use and price gradients (and the elasticity of supply of housing) make it very useful to have a general model which simultaneously explains these phenomena and permits us to make numerical estimates of them from easily obtainable data.

Interest in the property tax has been long standing from Marshall<sup>1</sup> and Edgeworth<sup>14</sup> to Simon<sup>11</sup>, Musgrave<sup>2</sup>, Netzer<sup>3</sup>, Rolph and Break<sup>4</sup> and Mieszkowski<sup>17</sup>, while concern with the determination of land values, use, and price gradients has continued from von Thünen<sup>5</sup> to Isard<sup>10</sup>, Alonso<sup>10</sup>, Shoup<sup>7</sup> and Rothenberg.<sup>6</sup>

There have been different competing views of the property tax and its effects. Marshall states that a tax levied on capital on a specific site will be borne by the owners of the land although he also says that a universal property tax may be shifted to consumers, while Rolph and Break extend the analysis to say that the tax will be paid by all site factors whose elasticities of supply are less than infinite. At the same time Simon takes the view

<sup>1</sup> Marshall, Alfred, Principles of Economics, eighth edition, appendix G, London; McMillan, 1952.

<sup>2</sup> Musgrave, Richard, The Theory of Public Finance, Mc-Graw Hill, New York, 1959.

<sup>3</sup> Netzer, Dick, The Economics of the Property Tax, Brookings Institution, Washington, D.C. 1966.

<sup>4</sup> Rolph, E.R. and G. Break, Public Finance, New York: Ronald Press, 1961.

<sup>5</sup> von Thünen, Der isolierte Staat in Beziehung auf Landwirtschaft und Nationaleconomie, Hamburg, 1863.

<sup>6</sup> Rothenberg, Jerome, "Strategic Interaction and Resource Allocation in Metropolitan Inter-governmental Relations," The American Economic Review, Volume LIX, May 1969, pp. 495-503.

that a tax on structures will be fully forward shifted to consumers as does Netzer appear to in the case of improvements to existing structures.

The difficulty and controversy over this question has largely originated out of the lack of a full analysis of the value of land. This paper proposes to put forth a model of land values, in which the value of a unit of a particular type of land is the difference between the marginal cost of increasing structure per unit land times the total quantity of structure minus the average cost of structure per unit land, which can be used to analyse the incidence and land use effects of property taxes along with the effect of location and transportation on land values and the land price gradient.

The property tax is actually a tax on the marginal cost of construction, which determines land values. Thus the previously expressed views of the property tax have merit but are incomplete or correct only under restrictive assumptions.

The analysis also develops a method of estimating the elasticity of supply of structures (housing, office etc.) on a fixed amount of land from data on the value of land and costs of construction of newly built units.

## I

Let us first assume a demand function which an entrepreneur faces for a particular type structure.

$$P = f(Q)$$

Demand function (1) is for a particular type of structure (i.e.,

number of square feet of high rise office space, number of square feet of low density residential housing) in a neighborhood of land which has constant locational attributes. All prices except that of  $Q$  are assumed to remain constant.

The locational and structural attributes which are held constant in (1) include the location of the site with respect to transportation facilities, location with respect to differing quantities of the same and other types of structures (high rise, low rise), and the quality and quantity of amenities in the neighborhood. The only assumption we make about the size of the neighborhood is that it is large enough to guarantee perfect competition in the provision of structural services  $Q$ . The price faced by the individual entrepreneur is thus constant for whatever quantity  $Q$  he supplies to the market.

Given this demand function, let us look at the cost function for  $Q$ , so that we may determine the quantity and density of structures supplied by the market.

Construction costs are assumed to depend on  $Q$  and  $T$ , the quantity of land used, in such a way that construction cost is equal to  $C(Q, T) = TC\left(\frac{Q}{T}\right)$ . This says that construction costs are proportional to  $Q$  for a given density  $\frac{Q}{T}$  (or that there are constant returns to scale at a particular ratio of structural space to land). Both capital and other factors of production of  $Q$  are assumed to be totally elastically supplied to the entrepreneur, though this need not be the case.

Total costs of providing  $Q$  on land  $T$  is equal to construction costs plus the cost of land. That is, total cost is

$$TC\left(\frac{Q}{T}\right) + V \cdot T \quad (2)$$

The total cost of providing Q consists of construction costs  $T \cdot C\left(\frac{Q}{T}\right)$  and land costs  $V \cdot T$  where V is the value or price per unit of land.

The entrepreneur or developer sees a constant V, land price per square foot, and chooses T so as to minimize the total cost of providing Q units of output.

Differentiating (2) with respect to T,

$$\frac{dC}{dT} = C\left(\frac{Q}{T}\right) - \frac{Q}{T}C'\left(\frac{Q}{T}\right) + V = 0 \quad (3)$$

or

$$\frac{Q}{T}C'\left(\frac{Q}{T}\right) - C\left(\frac{Q}{T}\right) = V \quad (4)$$

He then chooses to construct at density  $\frac{Q}{T}$  so that the price of land, V, (which he takes as given) is equal to the difference between the marginal cost of structure per unit of land times Q,  $\frac{Q}{T}C'\left(\frac{Q}{T}\right)$ , and the average cost of structure per unit land,  $C\left(\frac{Q}{T}\right)$ , the surplus accruing to land from the adding of a variable factor construction to a fixed factor land.<sup>7</sup> We will assume,  $C'\left(\frac{Q}{T}\right)$ , the marginal cost of increasing the amount of structure, Q, per unit land is rising,  $C''\left(\frac{Q}{T}\right) > 0$ .

If the marginal cost  $C'\left(\frac{Q}{T}\right)$  of structures per unit land is constant (or declining),  $C''\left(\frac{Q}{T}\right) \leq 0$ , there is no producer's surplus or Ricardian rent

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<sup>7</sup> Shoup, Carl, Public Finance, Chicago, Aldine, 1969, gives a verbal explanation of land values similar to this.



from density and  $V = 0$  in the competitive solution, the builder will pay no positive price for land, he could just increase density at constant cost as demand for structure increases.<sup>8</sup>

Now solve for  $\frac{Q}{T} = q(V)$  from (4) and find  $q'(V)$

$$q'(V) = \frac{1}{q C''(q)}$$

When  $C''(q) > 0$ , then  $q'(V) > 0$ .

Total cost is  $TC(q(V)) + V \cdot T$  from (2) (2)

which is equal to  $\left[ \frac{C(q(V)) + V}{q(V)} \right] Q =$  from (4)

and  $MC = \frac{C(q(V)) + V}{q(V)} = C'(q(V))$  (5)

Note that  $\frac{C(q(V)) + V}{q(V)} = C'(q(V))$  is equal to the average and marginal cost of construction of one more unit (i.e., square foot) of  $Q$  at density  $q$ . The average cost of one more unit is equal to  $\frac{C(q)}{q} + \frac{V}{q}$ , construction cost of a unit at a given density,  $q$ , plus land cost per unit (both constant to a perfect competitor who has no effect on either the cost of construction or land) which is equal to  $C'(q(V))$ , the marginal cost of obtaining an extra unit of  $Q$  by increasing density of  $Q$  per unit  $T$ . In equilibrium, the cost of obtaining more structure  $Q$  by building out

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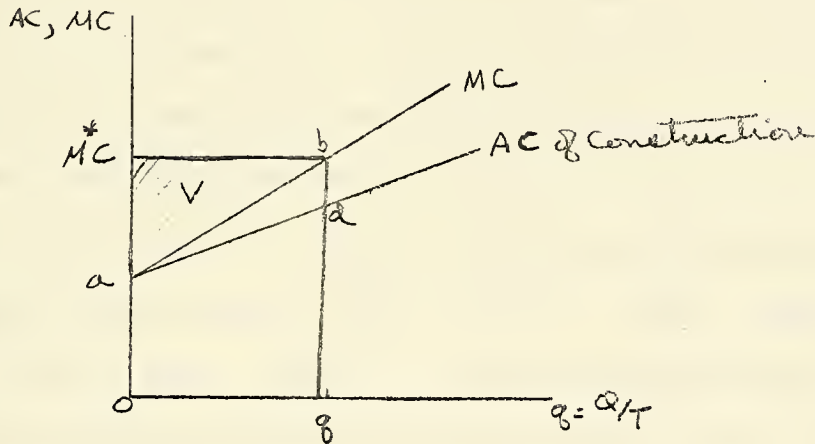
<sup>8</sup> Engineering information, positive land prices and diminishing returns to adding a variable factor, construction, to a fixed factor, land, all support the notion that  $C''(q) > 0$ .



at the same density  $q$ , is the same as the cost of obtaining more of structure  $Q$  by building more densely increasing  $q$ .<sup>9</sup>

Let us now graph the marginal and average cost of construction per unit of land.

Figure 1



<sup>9</sup> If there exists another neighborhood of land  $T_j$  which is only different from  $T_i$  with respect to distance from the center of a uni-model city, then the relationship between the price and cost of  $Q$  on the two neighborhoods of land will be

$$P_i = \frac{T_i C(Q_i/T_i) + V_i T_i}{Q_i} = C'(Q_i/T_i) = P_j + \sum_{l=0}^{\infty} \frac{E_l m(d_j - d_i)}{(1+r)^l}$$

$$= \sum_{l=0}^{\infty} \frac{E_l m(d_j - d_i)}{(1+r)^l} + \frac{T_j C(Q_j/T_j) + V_j T_j}{Q_j} = \sum_{l=0}^{\infty} \frac{E_l m(d_j - d_i)}{(1+r)^l} + C'(Q_j/T_j)$$

where

$$\sum_{l=0}^{\infty} \frac{E_l m(d_j - d_i)}{(1+r)^l}$$

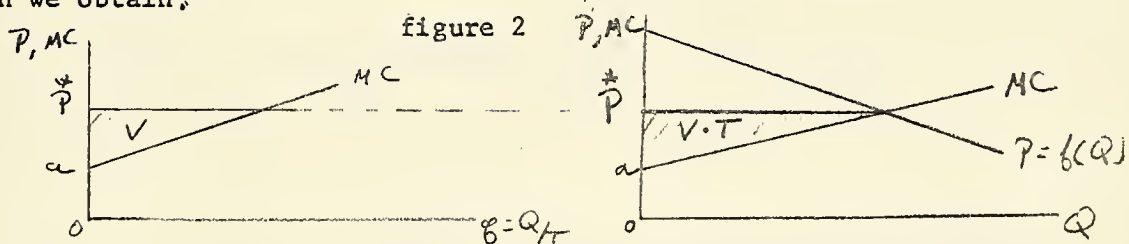
is the present discounted value of the cost of the additional travel to the center city from the further out land  $j$  at a cost per mile,  $m_i$  of additional travel  $d_j - d_i$ , and  $\bar{a}$  per period frequency  $E_l$  ( $m$  may vary with  $d$ ).

The entrepreneur would build  $Q$  to the point where the value of land,  $V$ , was equal to the difference between marginal cost (times quantity) and the average cost of construction per unit land,  $\frac{Q}{T}C'(\frac{Q}{T}) - C(\frac{Q}{T})$ , thus minimizing total cost for a given  $Q$  and setting  $V$ , the value of a unit of  $T$  equal to the triangle  $a, \bar{P}, b$  and to the rectangle  $(b-d) \cdot q$ <sup>10</sup> in figure 1.

He would only build if the price of  $Q$  was greater than or equal to the marginal cost of increasing the quantity of structure per unit land,  $P \geq C'(\frac{Q}{T})$ .

In perfect competition the value of land,  $V$ , would be bid up, or if land were available at a constant cost  $V$  more land would be brought into use for  $Q$ , until the marginal cost of construction of additional units were equal to the market clearing price,  $C'(\frac{Q}{T}) = \bar{P}$  when  $\bar{P} = f(Q)$  in demand.

The market supply curves for  $Q$  would then be the supply curve of  $Q$  (marginal cost) per unit land multiplied by the number of units of land,  $T$ . Diagramming both we obtain,



<sup>10</sup> We can see that the existence of minimum positive construction cost,  $a$ , when  $V = 0$ , will cause the value of  $V$  to rise at a greater rate than  $P$ , when  $P > a$ . If travel time costs cause the price of  $Q$  to be a decreasing function of distance from the central city, the value of  $T$  will decrease even more rapidly than the price of  $Q$ .

Alonso, William, Location and Land Use, Harvard University Press, Cambridge, 1964, and Isard, Walter, Location and Space Economy, M.I.T. Press, Cambridge, 1956 discuss land price gradients but do not give an adequate explanation of land price gradients for any case but the fixed  $q$  case.

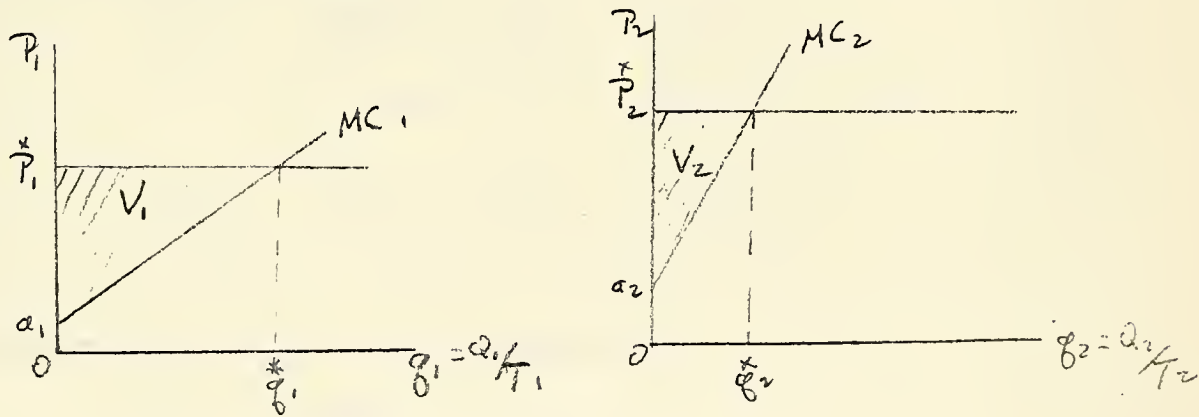
Land values are explained from consumer and producer utility and profit function with no consideration of the production functions for structures other than saying transportation costs effect utility and profits and that anything above normal returns which accrue to a business because of location will be bid away in land rents.

Where the triangle of producer's surplus in the per unit land case and the market case are equal to,  $V$ , the value of a unit of land and  $V \cdot T$ , respectively.

Let us now examine how an entrepreneur would decide what use to put a given piece of land into given competing demands for different types of structures.

The entrepreneur would look at the market prices of the two possible structural outputs,  $Q_i$ , and the cost of construction of each per unit land, then choose the structure which gave the largest producer surplus per unit,  $V_i$ , land when each structure would be built to the point where  $P_i = MC$  in equilibrium.

figure 3



Having examined the individual producer's determination of optimal type of structure and density of structure per unit land, we can now turn our attention to how this neighborhood of land would be divided among competing uses and how the value of land,  $V$ , and thus the density of each type of use would be determined.

Demands for structures of types  $i$  on the homogeneous neighborhood,  $\bar{T}$ , where  $i = 1, 2, \dots n$ .

$$\begin{aligned}
 P_1 &= f_1(Q_1 ; Q_2 \dots Q_n) \\
 P_2 &= f_2(Q_2 ; Q_1, Q_3, \dots Q_n) \\
 &\vdots \\
 P_n &= f_n(Q_n ; Q_1 \dots Q_{n-1})
 \end{aligned}
 \tag{6}$$

We are allowing the value of a particular type of structure  $Q_i$  to be a function of the amount of each other kind of structure built in the neighborhood so that economies of agglomeration, etc., are taken into account in our demand functions.

Our marginal costs are

$$\begin{aligned}
 MC_1 &= (C_1(q_1) + V)/q_1 = C'_1(q_1) \\
 MC_2 &= (C_2(q_2) + V)/q_2 = C'_2(q_2) \\
 &\vdots \\
 MC_n &= (C_n(q_n) + V)/q_n = C'_n(q_n)
 \end{aligned}
 \tag{7}$$

from (5).

In equilibrium, prices will equal marginal costs,

$$\begin{aligned}
 P_1 &= MC_1(V) \\
 P_2 &= MC_2(V) \\
 &\vdots \\
 P_n &= MC_n(V)
 \end{aligned}
 \tag{8}$$

and the derived demand for land in each use will be

$$\begin{aligned}
 T_1 &= Q_1/q_1(V) \\
 T_2 &= Q_2/q_2(V) \\
 &\vdots \\
 T_n &= Q_n/q_n(V)
 \end{aligned}
 \tag{9}$$



Market clearing requires

$$\sum_{i=1} T_i = \bar{T}$$

In (9),  $V$  determines  $MC_i(V) = P_i$  and  $P_i$  determines  $Q_i$  thus determining  $T_i$ .  $V$  is itself determined by  $\sum T_i = \sum Q_i/q_i(V) = \bar{T}$ .

The equilibrium values of  $Q_i$ 's,  $T_i$ 's, and  $MC_i$ 's will be determined by the demand functions, (6), the cost functions, (8), and the supply of homogenous land,  $\bar{T}$ .

Let us examine the derived demand curve for  $T$ , when the demand for  $Q_1$  is simply  $P_1 = f_1(Q_1)$ .

$$T_1 = Q_1/q_1(V)$$

differentiating

$$\frac{dT_1}{dV} = \frac{dQ_1}{dV} \frac{1}{q_1(V)} - Q_1 \frac{1}{q_1^2(V)} q'_1(V) \quad (10)$$

where

$$Q_1 = g_1(P_1) \quad \text{from (6),}$$

$$P_1 = MC_1(V) \quad \text{from (8)}$$

and

$$Q_1 = g_1(MC_1(V))$$

giving

$$\frac{dQ_1}{dV} = \frac{dg_1}{dP_1} \cdot \frac{dMC_1(V)}{dV}$$

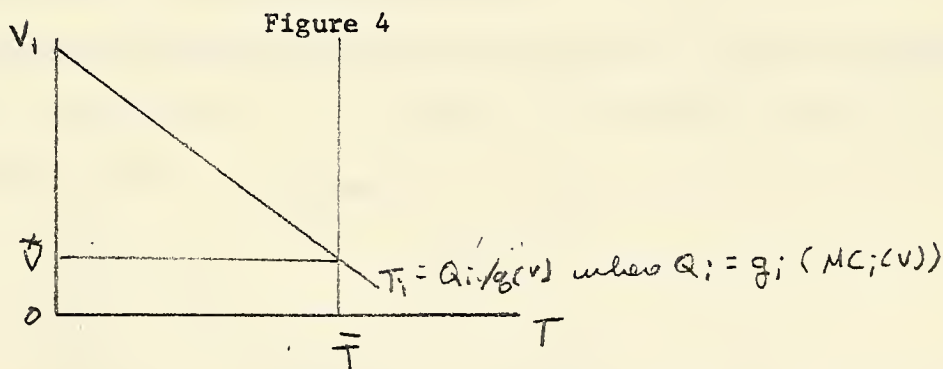
Since  $q'_1(V)$  and  $q_1(V)$  are both positive the second term in (10) is negative.

We have explained why  $\frac{dMC_1(V)}{dV}$  is positive and need only know the sign of  $\frac{dg_1}{dP_1}$  to discover the slope of the derived demand for land.

If demand for  $Q_1$  were infinitely elastic at a particular  $P_1$ ,  $\frac{dg}{dP_1}$  and  $\frac{dT}{dV}$  would be infinitely negative. If  $-\infty < \frac{dg}{dP_1} < 0$ , they will both be less than infinitely negative and demand for  $T_1$  downward sloping.

If there are economies of agglomeration in living in a community with a higher  $Q_1$  then  $\frac{dg}{dP_1}$  could be positive and the derived demand for land  $T_1$  could be upward sloping. We will note at this time that such a possibility is consistent with this analysis.

Let us now diagram the demand for  $T_1$  when it is downward sloping and there is no other demand for  $\bar{T}$ .

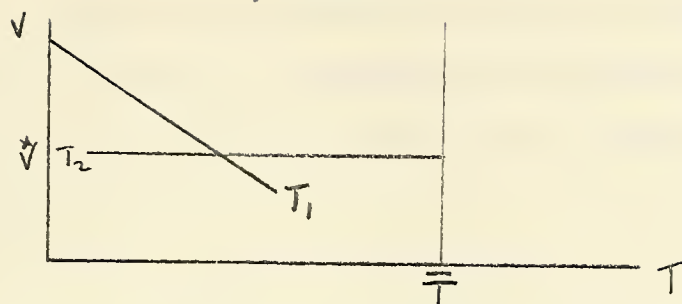


If  $T_1$  intersects the horizontal axis to the left of  $\bar{T}$ , the value of land will be zero in use 1, and  $Q_1$  would be built on the land at minimum density.

If demand for  $T_1$  intersects the X-axis to the right of  $\bar{T}$  then  $V > 0$  and  $q > 0$  with  $Q_1$ ,  $q_1$ ,  $P_1$ ,  $MC_1$  all being determined by  $V$ .

Now let us postulate two demands for land  $\bar{T}$ .  $T_1$  and  $T_2$  with the demand for  $T_2$  being infinitely elastic at  $\bar{V}^*$ .

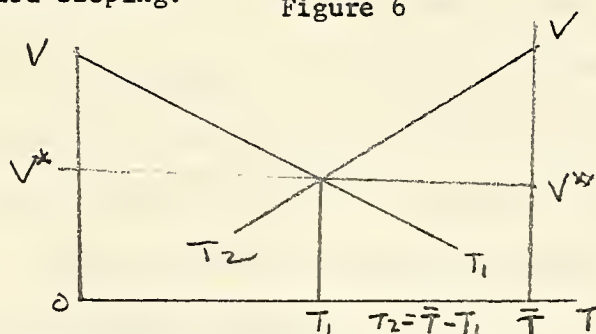
Figure 5



Now, as long as  $T_2$  intersects  $\bar{T}$  below and to the left of  $V^*$ ,  $T$  is available in use  $Q_1$  at a constant price  $V^*$ . Increases in demand for  $Q_1$  will thus result in increased  $Q_1$  and  $T_1$  at constant  $P_1$ ,  $MC_1$ , and  $q_1$ . This would be the case of farmland etc. which is available at constant cost in use  $T$ ; an unlikely case in developed urban areas where even farmland is more valuable the closer it is to the central city.

If there are other demands  $T_1$  with declining slopes, then an increase in the demand for land in use,  $i$ , will raise  $V$ . The supply of land in use  $i$  will be upward sloping.

Figure 6



This seems the most likely case in developed urban areas where there are competing uses for land.<sup>11</sup>

<sup>11</sup> We have postulated demand curves of the type  $P_1 = f_1(Q_1 ; Q_2 \dots)$ ,  $P_2 = f_2(Q_2 ; Q_1, Q_3 \dots)$  then not specified the interaction effects. Positive externalities between  $Q_1$  and  $Q_2$  could lead to  $T_1$  and  $T_2$  being upward sloping. If  $T_1$  and  $T_2$  both slope upward, increased demand for  $T_1$  will still raise  $V$  having the same effects on density and cost. A decrease in demand for  $Q_1$  and therefore  $T_1$  might lead to an increase in  $V$  if use  $Q_1$  imposed a negative externality on use  $Q$  in the area. We will assume zoning against negative externalities such that the phenomena does not occur in our general case.

Let us now examine the effect of the addition of a property tax  $t$  on structures  $Q$ . The tax is a percentage of the value of  $Q$ : thus the tax is of the form  $t P_n Q$  which is the same as an ad valorem tax on the MC of structure  $i$ .

$$P_g Q = (1+t)MC(V)Q$$

$$P_g = (1+t)MC(V)$$

where  $t$ ,  $P_g$  and  $P_n$  are respectively the present discounted values of the structure's gross rental, net rental and tax assessment. Note

$$P_n = MC(V).$$

What would the effect of such a tax be on  $P_i$ ,  $V$ ,  $q$ , and  $T_i$ ?

If the demand for  $Q$  and the supply of  $T_i$  both have elasticities which are greater than zero and less than infinity, then  $t_i > 0$  will cause  $P_i$  to increase and  $V$ ,  $Q_i$  and  $q_i$  to decrease.<sup>12</sup>

There are only two cases in which the property tax  $t_i$  can be fully forward shifted to consumers: totally inelastic market demand for  $Q_i$ , or totally elastic market supply of  $T_i$  at a given  $V$ , which is unaffected by the tax. Both of these seem highly unlikely and unrealistic assumptions with regard to land and structure markets in general and especially urban land and structure markets.

The property tax can only be fully backward shifted to the owners of land when there exists a totally elastic demand for  $Q_i$  or totally inelastic

<sup>12</sup> Imposing a property tax,  $\bar{t}$ , might lead to an increase in land values,  $V$ , if there was a type of structure,  $Q_i$ , which was elastically demanded and produced negative externalities to other structures  $Q_j$  in  $\bar{T}$ . The property tax could then reduce  $Q_i$  and  $T_i$  to the point where demand for  $Q_i$  increased enough so as to offset the property tax,  $t$ , and raise land values,  $V$ .



supply of  $T_1$  combined with a technology which only permits one density of structure,  $\bar{q}_1$ . Again, these assumptions seem unrealistic.

The contention made by Simon<sup>13,14</sup> that property taxes on structures are fully forward shifted would depend upon one or more of the previously stated assumptions, but I suspect that it rests upon looking at inelastically supplied land and totally elastically supplied capital rather than looking at the production or cost function for structures.

Simon also seems to say that if demand for  $Q$  were totally inelastic the tax would be borne by both land and consumers depending upon the percent of the total cost of  $Q$  which is devoted to land. Our analysis indicates that this is not the case. The difference probably stems from his looking at the tax as being levied separately on land and structure, not realizing that the value of land is itself determined by the marginal cost of adding structure to land.

Heilbrun<sup>15</sup> claims that the supply of structures on a given amount of land is infinitely elastic at a constant cost, which implies constant returns to a variable factor (construction) and constant marginal cost of increasing density, with land values being explained by monopolistic competition.

If the cost of increasing density is constant it would be difficult

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<sup>13</sup> Simon, Henry A., "The Incidence of a Tax on Urban Real Property," Quarterly Journal of Economics, May, 1943.

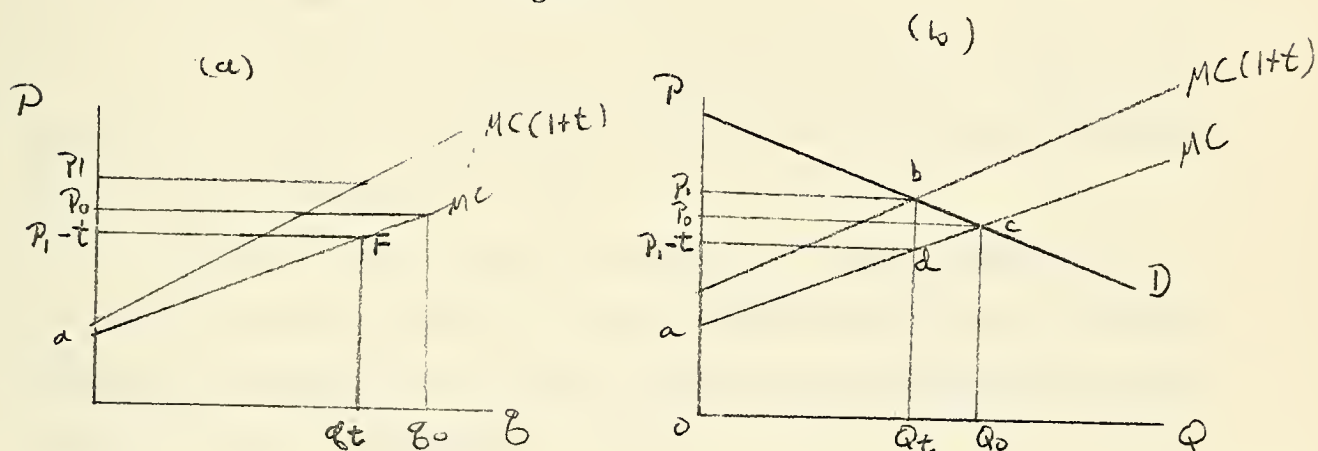
<sup>14</sup> Also see Edgeworth, F.Y., Papers Relating to Political Economy, New York: B. Franklin Press, 1925, whose argument is similar to and cited by Simon.

<sup>15</sup> Heilbrun, James, Real Estate Taxes and Urban Housing, New York, Columbia University Press, 1966.

to see why monopolistic competitors would pay positive prices for land which had no marginal product and which would be in excess supply at a zero price.

Diagramming the effect of a property tax when  $q_i$  is not fixed and the supply of land,  $T_i$ , is not infinitely elastic at a value,  $\bar{V}$ , which is independent of the tax.

Figure 7



In the absence of the tax  $Q_0$  would be supplied at density  $q_0$ , and price  $P_0$ : the total value of land,  $V \cdot T_i$ , would be the triangle  $P_0, c, a$  in figure 7(b), while the value on a unit of land,  $V$ , would be the triangle  $P_0, e, a$  in figure 7(a). The imposition of the property tax,  $t$ , reduces the total and per unit land quantities of structures supplied to  $Q_t$  and  $q_t$  respectively while increasing the price per unit to  $P_1$  and reducing  $V$  to the triangle labelled in figure 7(a).  $P_1 - t, f, a$ , The deadweight loss of the tax is the triangle  $b, d, c$  given that like taxes are not imposed on other substitute structures,<sup>16</sup> in figure 7(b).

<sup>16</sup> Harberger, Arnold C., "The Incidence of the Corporate Income Tax," Journal of Political Economy, June, 1962.

The imposition of taxes on other substitute structures would reduce the deadweight loss of the tax, since demand is always more inelastic for a gross class of good than for substitutes within it (ss 21).

Lump sum taxes on land only would have no deadweight loss and merely reduce the value of land by the present discounted value of such taxes.

It is also interesting to note that:

1. If a very small portion of the land  $\bar{T}$  is taxed at a higher rate the owners of such land will absorb almost the full burden and deadweight loss of the difference in tax rates.

2. Given the same production function for 2 types of structures  $Q_1$ , the type of structure which has the more inelastic demand curve will have a smaller deadweight loss as a result of the tax and will occupy a greater portion of  $\bar{T}$  than in the absence of taxes.

3. If labor, capital or any other factor used in the construction of structures is supplied less than totally elastically, it will also earn a quasi-rent which will be reduced by the imposition of a property tax.<sup>17,18,19</sup>

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<sup>17</sup> Mieszkowski, Peter, "On the Theory of Tax Incidence," Journal of Political Economy, June, 1967, volume 75.

<sup>18</sup> Grieson, Ronald E., Tax Incidence in a General Equilibrium Growth Model, mimeograph, presented to the summer 1967 Econometric Society Meetings, Toronto.

<sup>19</sup> Mieszkowski, Peter, "The Property Tax: An Excise Tax or a Profit Tax," Cowles Foundation Discussion Paper No. 304, November, 1970, analyses the effect of general property taxes on the gross and net return to capital under varying assumptions about the elasticity of supply capital and other factors of production.

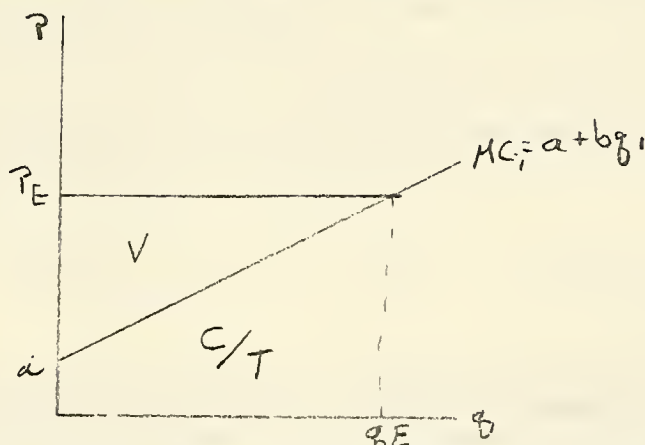
## II

Our analysis can be developed to permit the estimation of the marginal cost and elasticity of supply of  $Q_i$  on a fixed  $T_i$ , which will be the same as the average cost of building additional structures of type  $Q_i$  at the same density on more land (from  $\frac{C(q(V)) + V}{q(V)} = C'(q(V))$  or at a greater distance from the center city.

When looking at large shifts in demand this elasticity may be less than the elasticity of supply of structures when more land,  $\bar{T}$ , can be brought into use  $T_i$ .

We assume that the builders of new structures correctly estimate the long run equilibrium demand for each class of structures and the long run equilibrium land value,  $V$ , when deciding on the density,  $q$ , at which to build.

The method is to assume  $MC_i = a + bq_i$  and normalize so that  $q_E$  and  $P_E$  are both set equal to one.



If we now know the typical ratio of land value (or price) to construction costs in use  $i$  we can estimate the slope of  $MC_i$  and its elasticity.



Defining the ratio of land values to construction cost plus land values as  $X$  in use  $i$ ,

$$X = \frac{1}{2(1-a)}, \quad a = 1 - 2X, \quad b = 2X \text{ and}$$

the elasticity of supply of  $Q_i$  on  $T_i^*$  is  $\frac{1}{2X}$  (i.e., with  $X = \frac{1}{10}$ ,  $ES_{T_i}^* = 5$ ).<sup>20</sup>

Our estimate of the slope of  $M C_i$  combined with a measurement the elasticity of  $D_i$  would permit us to estimate the deadweight loss<sup>21</sup> and incidence of the particular tax (or if property taxes are levied generally the deadweight loss of property taxes which differ from the average and the deadweight loss of the average property tax for the nation as a whole).

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20 Real estate dealers inform me that the ratio of the cost of land to the cost of construction plus land in different uses varies from 1/10 to 1/20 for the largest office buildings to 1/4 to 1/5 for spacious suburban homes indicating elasticities of supply (on a given  $T_i$ ) of 5 to 10 and 2 to 2 1/2 respectively. Muth, Richard F., Cities and Housing, University of Chicago Press, has estimated elasticities of supply for residential housing of 5 to 14, but this estimate counts housing built further out as the same good as housing closer into the city ignoring transportation costs to the further out housing, thus overestimating the elasticity of supply of housing. The true elasticity would lie between my low estimates of 5 to 10 and his estimates of 5 and over.

21 If there exist other distorting property or sales taxes the net loss in welfare from placing a tax of  $t_Q$  on  $Q$  in the presence of an already existing tax of  $t_{Q_i}$  on  $Q_i$  can be expressed as:

$$-\frac{1}{2} \cdot Q \cdot P_{Q_0} \cdot t_Q \cdot E_{QQ} [t_Q - 2t_X] = -\frac{1}{2} \cdot R_Q \cdot E_{QQ} [t_Q - 2t_X]$$

with  $R_Q$  = the revenue from the tax on  $Q$ . This analysis by Harberger assumes a totally elastic supply of  $Q$  but could be extended to the case of less than totally elastic supply of  $Q$  by adding on the triangle under  $P_{Q_0}$ . The analysis can be extended to include a previously existing

distorting taxes. For further reference see Harberger, Arnold C., "Taxation, Resource Allocation and Welfare," in The Role of Direct and Indirect Taxes in the Federal Revenue System, National Bureau of Economic Research and The Brookings Institution, Princeton U. Press, 1964.

In conclusion, taxes on property cannot be forward shifted in the short run when the supply of structures is inelastic, and can only be partially forward shifted in the long run depending upon the elasticity of demand, the production function for structures and the amount of land available.<sup>22</sup>

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<sup>22</sup> Econometric studies of the incidence and capitalization of the property tax include:

i) Orr, L.L., "The Incidence of Differential Property Taxes and Local Public Spending on Property Values: An Empirical Study of Tax Capitalization and the Tiebout Hypothesis," Journal of Political Economy, November, 1969.

ii) Oates, W.E., "The Incidence of Differential Property Taxes on Urban Housing," National Tax Journal, September, 1968.

iii) Heinberg, J.D., and Oates, W.E., "The Incidence of Differential Property Taxes on Urban Housing: A Comment and Some Further Evidence:", National Tax Journal, March, 1970.

# Basement

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